International Journal of Mass Spectrometry 214 (2002) 171–173

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Book reviews

Application of Inorganic Mass Spectrometry
By John R. de Laeter, Wiley-Interscience Series on Mass Spectrometry, A Wiley-Interscience Publication, John Wiley & Sons, Inc., 2001, 474 pp., ISBN 0-471-34539-3

Inorganic mass spectrometry, which was developed more than 100 years ago, is today one of the most powerful analytical techniques for the multi-element determination of matrix, major and trace elements, for isotope ratio measurements and surface analysis in quite different materials. The book, *Application of Inorganic Mass Spectrometry* describes in 14 chapters different selected instrumental developments in mass spectrometry and their applications. The main topics of this substantial book focus preferentially on the author's special field in inorganic mass spectrometry—isotope ratio measurements with a broad description of different applications in metrology, nuclear science, cosmochemistry, geoscience, environmental science and planetary science. Today, John R. de Laeter is one of the leading specialists in precise and accurate isotope ratio measurements—the "doyen" of mass spectrometry in cosmochemistry and geoscience—and he is known for his multitude of excellent publications on this topic over a many decades.

Chapter 1 of the first part of the book gives a broad historical overview of different inorganic mass spectrometers since the "birth of modern mass spectrometry". For the author, the beginning of modern inorganic mass spectrometry was the introduction of the 60° magnetic sector mass spectrometer by A.O. Nier in 1947. Nier's sector field mass spectrometer was used for the first time to separate microgram quantities of ^{235}U from ^{238}U, thus enabling the fissionable nature of ^{235}U to be established.

After an historical introduction, magnetic sector ion optics (the sector field mass spectrometer), including the basic theory of separating ions of different mass in magnetic field and abundance sensitivity, is described as the most important instrumental parameter that affects the ultimate accuracy of the measured isotope abundance ratios. Selected ionization methods which are important for precise isotope ratio measurements (e.g., thermal ionization including the application of negatively-charged thermal ions for elements with high electron affinities) and ion collection systems as the two components of a mass spectrometer are discussed in detail together with basic theories. In the following chapters of the first part, the principles, capability and application fields of the most important inorganic mass spectrometry methods are summarized starting with secondary ion mass spectrometry (SIMS), followed by accelerator mass spectrometry (AMS), inductively coupled plasma mass spectrometry (ICP-MS) and other mass spectrometric techniques, such as spark source mass spectrometry (SSMS), glow discharge mass spectrometry (GDMS), Knudsen effusion mass spectrometry, small volume mass spectrometer with Mattauch–Herzog geometry for space research, resonance ionization mass spectrometry (RIMS) and Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR-MS). Whereas the author devotes considerable attention to the discussion of expensive mass spectrometric techniques not in widespread use, such as SIMS and AMS with some exotic applications, ICP-MS as the "major development in mass spectrometric instrumentation" (author's remark) at the present time is dealt with in a quite stepmotherly fashion. The main part focuses on a description of the physical principles of quadrupole and time-of-flight (TOF) mass analyzers. Twenty-nine references in this chapter (with the oldest reference on TOF from 1946 and the average year of publications cited being 1987—ICP-MS was developed in 1980) are unfortunately rather outdated and the citation of any relevant modern references is missing. With respect to sector field ICP-MS, only the "Plasma 54" manufactured by Fisions Instruments was discussed.

The second part of de Laeter's book on "Inorganic Mass Spectrometry" starts with an extended chapter on "Metrology" which describes in detail the determination of atomic masses, isotopic abundances, atomic weights and fundamental constants (e.g., the Avogadro, Faraday and Universal Gas Constant). The important role of certified standard reference materials (SRMs), especially for the determination of isotope ratios, and the description of measurements is discussed by the author in the "Reference Materials" chapter which gives a good overview of the SRMs available and selected internal measurement evaluation programs.

For radioanalysts, geologists, geochronlogists and cosmologists, the following chapters on the application of inorganic mass spectrometry in "Nuclear Science", "Cosmochemistry" and "Geoscience" are useful. Fundamentals of neutron capture, radioactive decay, nuclear fission (including geochemical and geological studies on the Oklo Natural Reactor), reactor physics etc. together with the application of different mass spectrometric techniques are described. Inorganic mass spectrometry for applications in cosmochemistry is further used to investigate "the composition and evaluation of matter in the universe, and in particular the solar system", in which connection besides the elemental abundances in meteorites, this chapter also deals with isotope anomalies and the application of cosmochronology. Of particular interest for geochemists are the different age dating techniques (such as U/Th–Pb, ^{87}Rb–^{87}Sr, ^{147}Sm–^{143}Nd, ^{187}Re–^{187}Os etc.) for geological samples in geoscience.

The chapter on the application of inorganic mass spectrometry, "Environmental Science", for the determination of heavy metals, migration of radioisotopes in the earth's crust, climate change and hydrology studies focuses mainly on the earlier research using isotope dilution mass spectrometry (IDMS) together with TIMS and the application of AMS for the determination of low-concentrated exotic nuclides (e.g., ^{129}I, ^{36}Cl, ^{14}C). Nowadays, especially ICP-MS and LA-ICP-MS—both techniques are not mentioned—play an important role in environmental research.

In the "Planetary Science" chapter, again studies on extraterrestrial bodies (such as the planets Mars, Jupiter and Saturn, comets, the moon and meteorites) are summarized. In the chapters on "Materials Science" and "Other Applications" several very special examples are described and discussed.

The book "Inorganic Mass Spectrometry" by de Laeter is comprehensive with the main topics concentrating on isotopic analysis for the geological sciences. An insufficiency of the book is that of about 1150 references out of which 75% are older than 20 years. New instrumental and methodological developments in inorganic mass spectrometry, especially in sector field and quadrupole ICP-MS with single- and multi-ion collectors, in LA-ICP-MS, the use of collision cells or different coupling techniques (such as capillary electrophoresis (CE), gas chromatography (GC) or high performance liquid chromatography (HPLC)) including interesting applications of these methods in the different scientific fields are not described.

In summary, I think that the book is of main interest for specialists in isotope ratio measurements in geoscience and cosmochemistry.

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PII S1387-3806(01)00577-2